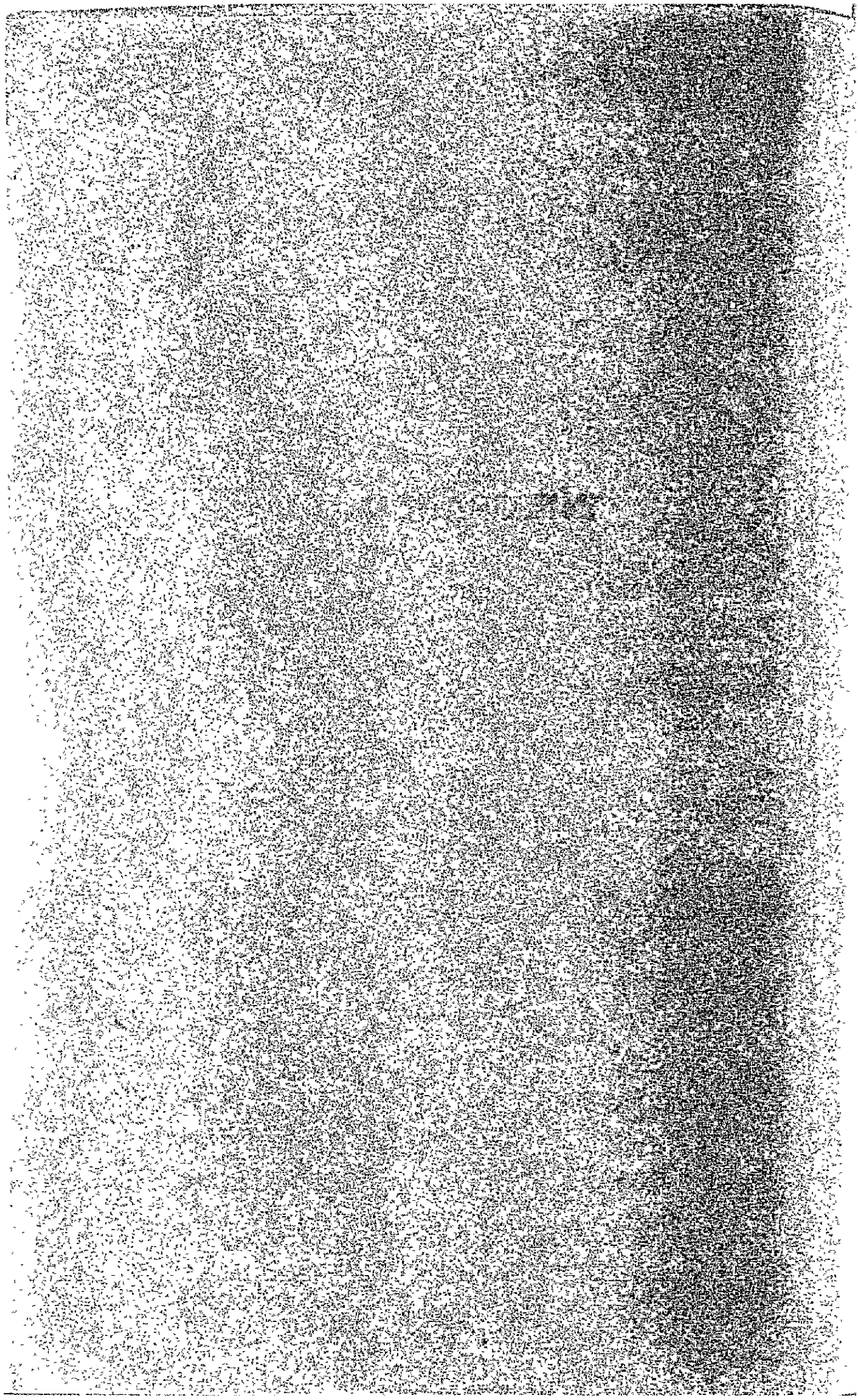
INTEGRATION



CHAPTER 10 IMPACT OF THE RING ROADS

The functions of the Ring Roads are briefly summarized below.

(1) Ring roads will service traffic between places along them and make trips around the city easier. Land-uses along the ring roads will grow.

(2) The ring roads will make the traffic flow to and from the urban center more multi-directional.

(3) Since the ring roads are used by through traffic to by-pass the city center, traffic that is not necessary to the urban center will be reduced.

(4) The ring roads are very useful for distribution of goods. The distribution centers to be located along the ring road should function very efficiently.

The impacts of the ring roads when they become fully functional as described above, are as follows:-

10.1 Environmental Impacts

10.1.1 Positive impacts

(1) The release of traffic congestion and the improvement of the environment in urban centers

If the road network to avoid the city center is not improved, traffic in the urban center will be more congested in the future, as the traffic volume increases.

By using the ring road, traffic can easily be detoured away from the city center and the traffic congestion in the urban center will be reduced. At the same time, the environment of the urban center will be improved with the reduction of noise and air pollution. It is forecasted that the traffic volume of arterial roads in the urban center will be reduced 25 - 50% with this project (Case 1) compared to "without project" (Case 2) in 2000.

Fig. 10.1 Arterial Roads in the City Center

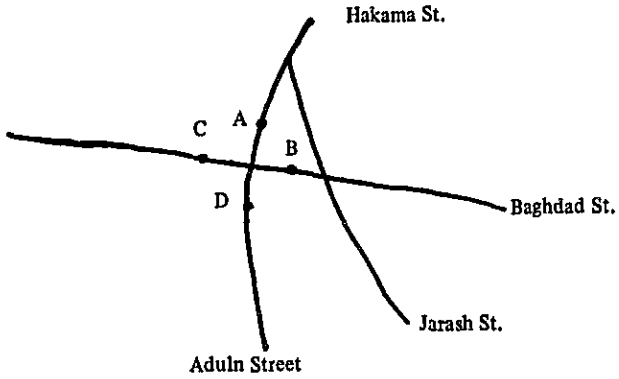


Table 10.1 Effect on Release of Traffic Congestion in the Year 2000

Point	With the Project (Case 1) (Vehicles/day)	Without the Project (Case 2) (Vehicles/day)	Amount Reduced Case 2 - Case 1. Case 2
A	10811	21454	49.6 %
B	21994	32992	33.3 %
C	22451	32522	31.0 %
D	4546	6088	25.3 %

(2) The creation of amenities in the urban center

As was mentioned before, by using the ring roads it becomes easier to reroute through traffic and thus it will be possible to adopt a traffic cell system in the urban center, as shown in Figure 3.8. By having a pedestrian way, the amenities of the urban center will be increased.

10.1.2 Negative impacts

(1) Noise and dust of construction work

The route of the ring roads does not pass through areas that are heavily populated. So, it is obvious that if the contractors carry out the work carefully, this ring road will cause little noise and dust problems.

(2) Traffic Noise

When the ring roads are in operation, traffic noise becomes a problem.

The traffic noise generated by a vehicle is a compound of sounds caused by:

- Engine
- Power transmitting devices
- Gas exhaustion
- Vehicle's movement through the air
- Tyre contact with the road surface

The sound level caused by the moving vehicle is negligible compared with the other elements. The other causes are grouped into machine noise, including sounds of the engine, transmitting devices and gas exhaustion and the tyre sound.

In general, the level of the tyre sound is higher than that of the machine noise in higher gears and vice versea in lower gears. The sound level is proportional to the travelling speed at higher speeds and to the engine revolutions at lower speeds.

(a) Traffic Noise Formula

For a constant traffic flow of more than 1,000 vehicles/hour on a highway where the travel speed ranges from 30 km/hr to 100 km/hr, the formula for sound level in a zone 100 m wide along the road edge is as follows:

$$L_{50} = Lw - 8 - 20 \cdot \log_{10} L + 10 \cdot \log_{10} \left(\pi \cdot \frac{L}{d} \cdot \text{Tan h} \cdot 2\pi \frac{L}{d} \right) + a$$

where:

L_{50} : Middle Sound Level (dB)

Lw : Average Sound Level by a Vehicle (dB)

L : Distance from Lane Center to Sound Receiving Point (M)

$d : \frac{1000\ V}{Q}$ (M)

Q : Traffic Volume (vehicles/hour)

V : Traffic Speed (km/hr)

a : ad + al

ad : Compensation by Diffraction (Fig. 10.2)

al : Compensation by Surrounding Conditions (Fig. 10.3)

Formula for Average Sound Level by a Vehicle :

$$Lw = 87 + 0.2\ \bar{V} + 10 \cdot \log_{10} (a_1 + 10\ a_2)$$

where:

Lw : Average Sound Level by a Vehicle (dB)

$\bar{V}$: Traffic Speed (km/hr)

a_1 : Proportion of Small Vehicles

a_2 : Proportion of Large Vehicles

$(a_1 + a_2 = 1)$

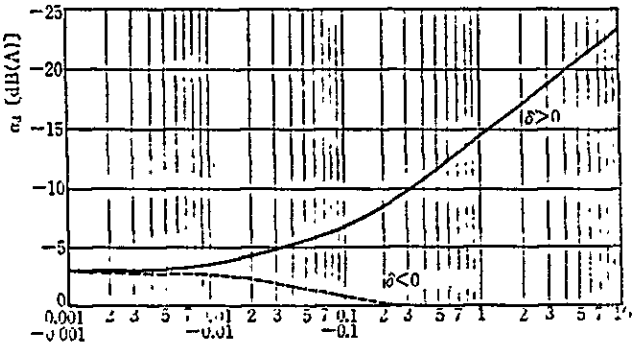
Note : This formula is based on the classification of vehicles into two types: small and large.

The calculation example for an ordinary road with four lanes is as shown in Figure 10.4 under the following conditions:

- traffic volume Q = 2000 vehicles/hour
- proportion of large vehicles a_2 = 0.2
- traffic speed $\bar{V}$ = 50 km/hr

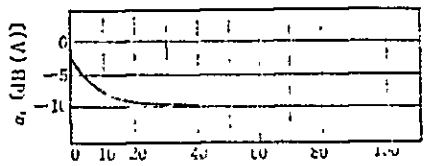
Source : The problems concerning road environment, Ogiwara, Kanayasu. Road, June 1976).

Fig. 10.2 Compensation by Diffraction



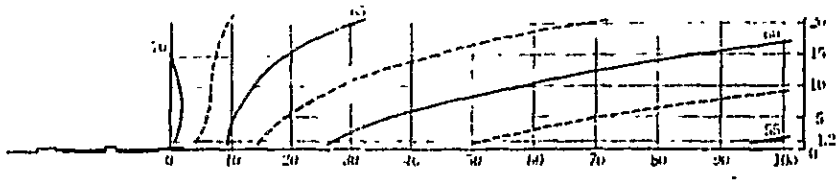
Difference distance between diffraction and straight line

Fig. 10.3 Compensation by Surrounding Conditions



Distance from the shoulder (m)

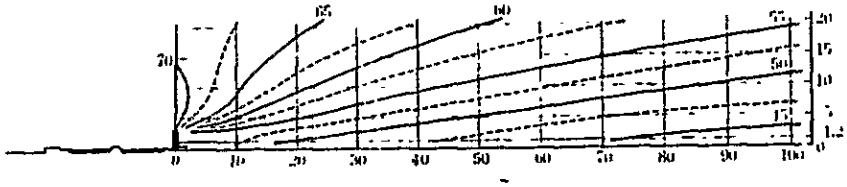
Fig. 10.4 Calculation Example of Noise



Height from ground level

Distance from base point

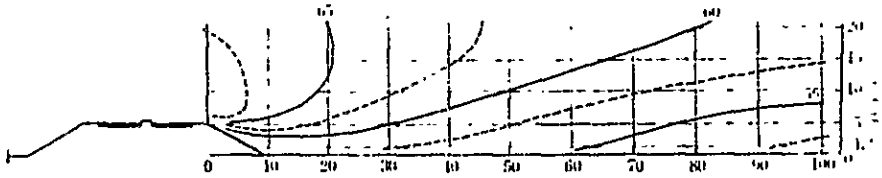
Flat, Ordinary road, Wall height 0m,
Velocity 50 Km/hr



Height from ground level

Distance from base point

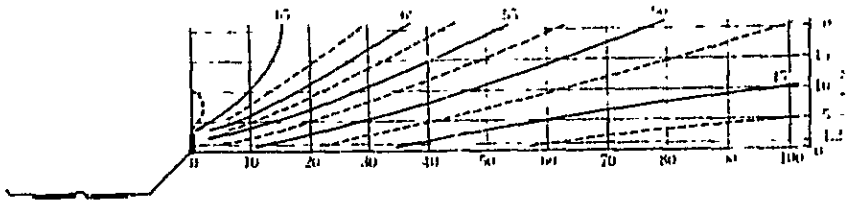
Flat, Ordinary road, Wall height 3m,
Velocity 50 Km/hr



Height from ground level

Distance from base point

Flat, Ordinary road, Wall height 0m,
Velocity 50 Km/hr



Height from ground level

Disance from base point

Flat, Ordinary road, Wall height 3m,
Velocity 50 Km/hr

b) Case Study

Boundary Ring Road

The maximum traffic volume of a two-lane section in the residential area for the year 2000 is forecast to be 600 vehicle/hour and that of four-lane section, 1400 vehicles/hour. The proportion of large vehicles (a_2) is forecast to be 0.1 in both sections.

Outer Ring Road

The maximum traffic volume of a two-lane section in residential area for the year 2000 is forecast to be 1000 vehicles/hour. The proportion of large vehicle (a_2) is forecast to be 0.05.

In the peak traffic hour, it is forecast that vehicle speed will be reduced to between 60 - 40 km/hm.

The forecast of traffic noise at the edge of the R.O.W. of the road (0m) and the point of 10 m apart from the edge of the R.O.W. of the road (10m), for vehicle speeds (V) is 60 and 40 km/hour is shown in Table 10.2 (Height 1.2 m from ground level).

Fig. 10.5 Road Section

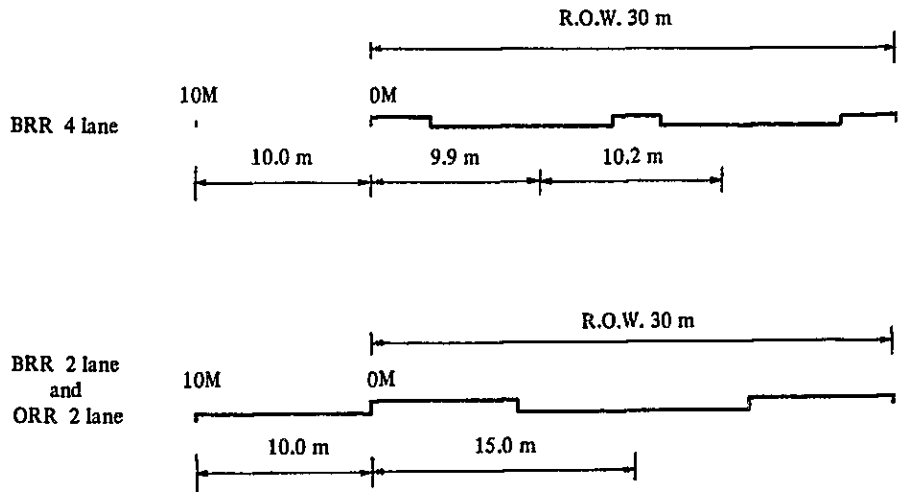
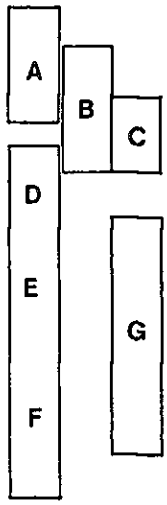


Table 10.2 Forecast of Traffic Noise (In 2000)

(Unit Phon)

			40 km/h	60 km/h
Boundary Ring Road	2 lane	0m	58.3	60.2
		10m	51.8	54.0
	4 lane	0m	62.2	64.2
		10m	55.2	57.7
Outer Ring Road	2 lane	0m	60.0	62.2
		10m	52.6	55.2

Table 10.3 Example of Noise for Various Phon Levels



-100 Under the railroad tracks where a tram car passes.

-90 Noisy factory

-80 Inside tram car
Ordinary factory

-70 Noisy office
Quiet factory

-60 Usual conversation

-50 Quiet office
Library

-40 Midnight in the city

-30 Studio
Midnight in the suburbs

A Street car road

B Vehicles passing road

C Office building street

D Side street

E Residential area in the city

F Park

G Residential area in the suburbs

Table 10.4 Maximum Acceptable Level of Traffic Noise

(Unit: Phon)

	Lane	Daytime	Morning and Evening	Night
Exlusively Residential District No.1	1 lane	55	50	45
	2 lanes	70	65	55
	over 2 lanes	75	70	60
Exclusively Residential District No. 2	1 lane	60	55	50
	2 lanes	70	65	55
Residential District	over 2 lanes	75	70	60
Neighbourhood Commercial District	1 lane	70	65	60
Commercial District	2 lanes	75	70	65
Quasi Industrial District Industrial District	over 2 lanes	80	75	65

Source : Japanese Government, Ministry of Public Welfare, 1971

c) Traffic noise criteria and countermeasures

Example of actual noise is as shown in Table 10.3.

No regualtions to limit traffic noise exist in Jordan. As a reference, acceptable limits of traffic noise in Japan is presented in Table 10.4.

The peak of traffic volume appears in the morning and evening.
It is requsted in Japan that the noise should be less than 65 phon in residential area for 2-lane roads and 70 phon for over 2-lane roads. However, it is desirable that noise is less than 65 phon in residential areas in both cases.

In Irbid City, it is decided by land-use regulations that housing should be set back 3 - 5m from the road edge.

In any case, traffic noise will be less than 65 phon. Therefore its noise level will be acceptable.

(3) Vibration

Vibration by traffic depends mainly upon the structure of the sub-base course and the condition of the pavement surface.

Since the sub-base course of the ring roads is good, vibration will not cause problems, assuming that execution of the pavement is well carried out.

(4) Exhaust Gases

It is very important that the vehicle's motor be imporved to reduce exhaust gases.

Exhaust gases will remain a problem for the environment as long as vehicle motors are not so improved. Hence, the improvement of vehicles is a necessity.

Fruit trees (olive, fig, etc.) are planted along the Boundary Ring Road in the north-western area of the city. It is known that acute emission pollutants adversely affect fruit production by interfering with the blossom setting process.

The condition of the wind in Irbid City is as shown in Table 10.5.

The frequency of calm state is only 6.4%. Frequency of 1 - 21 knots (1.9 - 38.9 km/h) wind reaches 92%.

The wind direction in Irbid City is almost always westerly. Accordingly, exhaust gases will be dispersed by the wind and will cause little problem.

(5) Disruption of Community

The neighbourhood community is usually formed in the area of approximately 1 km x 1 km.

Ring roads are approximately arranged at 1 km intervals from Inner Ring Roads.

Accordingly, disruption of the community will not become a problem if the ring roads form the boundary of the neighbourhood.

It will be necessary to arrange crosswalks at intervals of about 500 m across the ring roads.

(6) Destruction of Nature

The existing farmland along the ring roads will be changed to urban use by the year 2000 whether it is desirable or not.

It is clear from site reconnaissance that neither especialy important animals and plants nor archeological ruins exist along the corridor.

Table 10.5 Wind Summary in Percentage (%)

Station: IRBID

Direction / Speed	Calm	N	NL	E	SSE	S	SW	W	NW	Total
Calm	6.44									6.44 %
1 - 10*		1.67	1.00	5.20	3.80	4.47	5.36	34.45	6.76	62.71 %
11 - 21		0.31	0.23	1.50	2.33	1.79	2.66	17.66	3.19	29.67 %
22 - 33		0.003	0.01	0.10	0.28	0.22	0.16	0.32	0.02	1.11 %
34		0.003		0.01	0.003	0.02	0.01	0.02	0.003	0.07
Total	6.22	1.99	1.24	6.81	6.41	6.50	8.19	52.45	9.97	100,00 %

* Wind Speed in Knots . (1 Knot = 30.9m/min)

Source: Meteorological Directorate Statistic Division

10.2 Socio–Economic Impact

10.2.1 Positive Impact

(1) The area along the ring road will be developed as a residential area. Therefore, the absolute value of the land will be increased.

The Boundary Ring Road and the Outer Ring Road are very important as the arterial roads inside the district. The Boundary Ring Road will become the arterial road of approximately 780 ha of residential area.

The Outer Ring Road will become the arterial road of approximately 430 ha of residential area.

This impact has the largest benefit which is not based on the volume of traffic.

(2) A good residential area will be established along the Boundary Ring Road and the Outer Ring Road.

Accordingly, the urban areas having a high population density inside the inner city will decrease.

(3) District Centers (commercial areas) can be developed besides intersections of the Boundary Ring Road and the existing radial arterial road.

These centers will be very effective in preventing a concentration in the traffic flow to the urban centers.

(4) Access to the industrial area will become easier and the absolute value of the industrial land will increase.

(5) A truck terminal is planned to be located along the Outer Ring Road inside the industrial area. It will function effectively with the ring road.

10.2.2 Negative impacts

(1) Displacement of Houses

The number of houses to be displaced will be 30 by the Boundary Ring Road and none by the Outer Ring Road.

Sufficient compensation is necessary and new land should be prepared for displaced people, if necessary.

(2) Increase of Land Prices by Public Investment

The land prices along the ring road will increase. Accordingly the price of land in other areas will also increase induced by the land prices along the ring road.

This general increase in land prices is a phenomenon which is inevitable with public investment in a free market.

CHAPTER 11 IMPLEMENTATION PROGRAM

11.1 Staged Construction Schedule

The construction of the Ring Roads requires a large investment, and for this reason and to obtain maximum economic benefit a staging of construction is adopted.

The eastern part of the Boundary Ring Road (Section 1) and Outer Ring Road have priority to be constructed in an early stage taking into consideration the large traffic demand due to planned the industrial estate, truck terminal, and housing project in the eastern part of Irbid City.

On the other hand, in order to mitigate the traffic congestion of Route 16 in the center of Irbid city, the construction of the northern part of Boundary Ring Road (Section 2) or rather the southern part of Boundary Ring Road (Section 3) is necessary.

Therefore, the Study Team proposed two alternative construction schedules as follows:

(1) Alternative I

1) First Stage Construction (Completed by 1985)

- Boundary Ring Road of Section 1, 2, and 3
- Connecting Road
- Outer Ring Road

2) Second Stage Construction (Completed by 1995)

- Widen Boundary Ring Road of Section 1 to four lanes

(2) Alternative II

1) First Stage Construction (Completed by 1985)

- Boundary Ring Road of Section 1 and 3
- Connecting Road
- Outer Ring Road

2) Second Stage Construction (Completed by 1990)

- Boundary Ring Road of Section 2

3) Third Stage Construction (Completed by 1995)

- Widen Boundary Ring Road of Section 1 to four lanes

Note: The section of the Boundary Ring Road between its intersections with Bab Al-Wadd Street and Baghdad Street, and the roads from the urban center joining connecting Roads A and B are not included in this project since they are planned to be constructed by Irbid Municipality.

Since the roads planned in this project will be completed by 1985, interfacing of city roads should be completed before 1985.

11.2 Implementation Schedule

The implementation and investment schedule are shown in Tables 11.1 and 11.2 for Alternatives I and II, respectively.

- The detailed design including a review of the Feasibility Study will commence in the beginning of 1982 and, consequently, tender documents for construction are to be prepared.
- Modification of the land readjustment plan to match with the proposed Ring Roads should be urgently started.
- Land acquisition and compensation will commence in the beginning of 1982.
- When land acquisition and compensation are completed, the contract for construction can be approved and awarded.
- Mobilization for construction can begin after the contract has been awarded.
- Widening Boundary Ring Road Section 1 to four lanes should be completed by the end of 1995.
- Over-lay of an additional asphalt surface should be performed after 10 years of road use.

Table 11.1 Implementation and Investment Schedule (Alternative I)

Item \ Year	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	1	2	3	4	5	6	7	8	9	10	Total
Detailed Design and Tender	———												———																	
Land Acquisition and Compensation	———																													
Construction			———	———										B B R Sec. 1 (1st stage) ———																
Over-lay of Asphalt Surface														———										———						
Maintenance					———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	
Engineering, Supervision and Administration	85	85	92	91									35	40										6						454
Land Acquisition and Compensation	1,179	1,178																												2,357
Construction			1,940	1,940										380																4,260
Over-lay of Asphalt Surface														446										66						512
Maintenance					3 6	3 6	3 6	3 6	108 7	3 6	3 6	3 6	3 6	108 7	4.3	4 3	4.3	124.8	4.3	4.3	4 3	124 8	4.3	4.3	108 7	4 3	4 3	124.8	4 3	776.6
Total	1,264	1,263	2,032	2,031	3 6	3 6	3.6	3 6	108.7	3.6	3 6	3 6	38.6	974 7	4.3	4.3	4 3	124.8	4.3	4.3	4.3	124 8	4 3	76.3	108.7	4.3	4.3	124.8	4 3	8,339 6

Table 11.2 Implementation and Investment Schedule (Alternative II)

(Unit 1,000 JD)

Item \ Year	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	1	2	3	4	5	6	7	8	9	10	Total
Detailed Design and Tender	———							———					———																	
Land Acquisition and Compensation	———																													
Construction			———	———					B B R. Sec 2 ———					B B R Sec. 1 (2nd stage) ———																
Over-lay of Asphalt Surface														———					———					———						
Maintenance					———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	———	
Engineering, Supervision and Administration	55	55	61	60				55	67				30	35					10					6						434
Land Acquisition and Compensation	1,179	1,178																												2,357
Construction			1,271	1,271					1,338					380																4,260
Over-lay of Asphalt Surface														337					109					66						512
Maintenance					2.7	2.7	2.7	2.7	82	3 6	3 6	3.6	3 6	108.7	4.3	4.3	4.3	108.7	4.3	4.3	4.3	124.8	4.3	4.3	108.7	4.3	4.3	124 8	4.3	730.2
Total	1,234	1,233	1,332	1,331	2.7	2.7	2.7	57.7	1,487	3.6	3 6	3 6	33 6	860.7	4.3	4 3	4.3	108.7	123.3	4 3	4.3	124.8	4.3	76 3	108 7	4.3	4.3	124 8	4.3	8,293.2

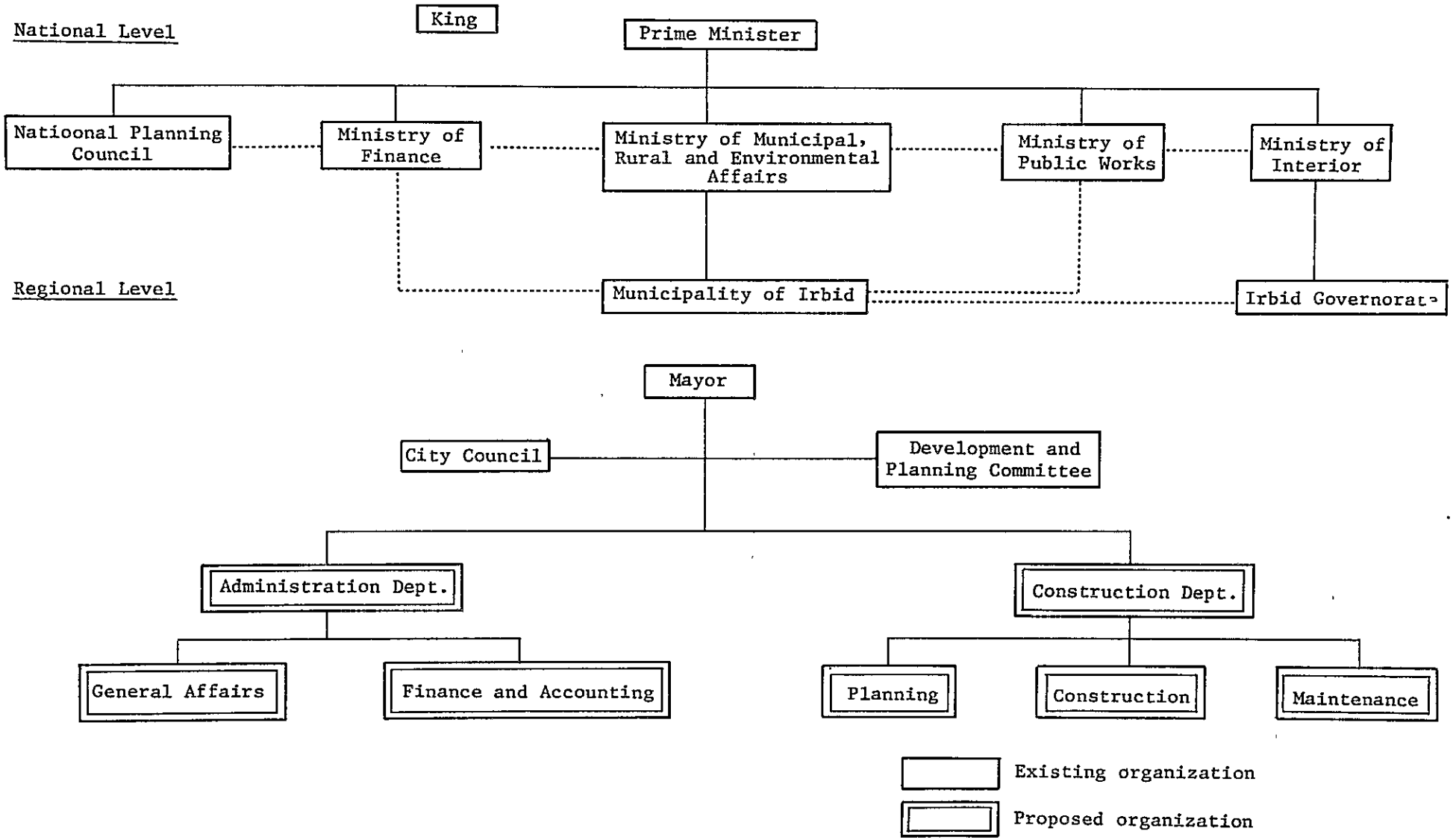
11.3 Executing Agency for Construction

The Municipality of Irbid is the agency responsible for the execution for road construction. The necessary land acquisition and compensation for the land and property within the proposed right-of-way should be undertaken prior to the start of construction by this agency.

Other concerned government agencies are the Ministry of Municipal, Rural and Environmental Affairs, the Ministry of Public Works and the Ministry of Finance.

The proposed project organization structure for execution of the Ring Roads is shown in Fig. 11.1.

Fig. 11.1 Organization Structure



11.4 Financial Considerations

According to the Municipality of Irbid, the annual budgets for road development in 1980 and 1981 were as follows:

(x 1,000 JD)

Item	1980	1981
Construction	390.972	400
Maintenance	64.36	100
Loan from Government	-	92.5
Total	455.332	592.5

The budget for the Ring Road stated in the 1981-1985 Five-Year Development Plan is as follows:

(x 1,000 JD)

Sources	1982	1983	1984	1985	Total
Municipal and Foreign	150	900	1,000	450	2,500
Central Government	100	350	500	50	1,000
Total	250	1,250	1,500	500	3,500

As shown above, the budget for Ring Roads is insufficient. Consequently, strong financial support by the Government of Jordan and loans from foreign countries are needed and should be arranged as soon as the project is approved.

CHAPTER 12 ECONOMIC ANALYSIS AND PROJECT EVALUATION

12.1 Economic Analysis of the Alternatives

The main objective of this section is to determine the most economically feasible alternative of the ring roads. Construction costs and project benefits of each alternative have already been dealt with in earlier chapters.

In this section, economic analysis was carried out using the cost and benefit data. In the analysis, the following economic criteria were applied to each of the alternatives:

1. Cost-Benefit Ratio (B/C)
2. Net Present Value (NPV)
3. Internal Rate of Return (IRR)

Costs and benefits were calculated without duties since duties are the reallocation of resources and have no economic effect to the economic activity of Jordan.

Costs and benefits which occur in the future must be discounted to the present value in order to have a common basis for comparison. Upon the suggestion of the Ministry of Public Works, the discount rate of 10 percent was adopped in this study.

The costs, benefits and the values of economic criteria are summarized in Table 12.1.

Table 12.1 Summary of Economic Analysis
(Discounted at 10% using 1981 prices)

(Unit : 1,000 JD)

		Alternative I	Alternative II
(1)	Total Discounted Costs	4,977	4,563
(2)	Total Discounted Benefits	11,082	11,044
	Operating cost saving	5,893	5,883
	Time saving	5,189	5,161
(3)	Cost-Benefit Ratio (B/C) ((2) ÷ (1))	2.23	2.42
(4)	Net Present Value (NPV) ((2) - (1))	6,105	6,481
(5)	Internal Rate of Return (IRR)	18.1%	19.7%

Source: Study Team

Discounted costs total about JD 5 million and discounted benefits total about JD 11 million for both alternatives. The B/C ratio is 2.23 to 2.42 which indicates that benefits are expected to be twice amount of costs in both alternatives. The project has about JD 6 million net present value and 18.1 to 19.7 percent IRR. Therefore both alternatives are economically feasible.

Comparing Alternative I with Alternative II, Alternative II is more recommendable than Alternative I. Benefits are almost the same in both alternatives, but costs of Alternative II are less than Alternative I because construction of Section 2 of the Boundary Ring Road is delayed by 5 years in Alternative II.

This means that Section 2 of the boundary ring road doesn't produce benefits especially in the beginning of the project, that benefits are almost same in both alternatives.
Therefore Alternative II was selected as more suitable and more recommendable.

12.2 Sensitivity Analysis

The effect of changes in the level of costs and benefits are examined by sensitivity analysis concerning Alternative II.

The level of costs which is estimated in this study doesn't change much because there are no large strucrures in this project and the land topography is relatively simple. Therefore, the case of increasing costs by 10% was examined.

For benefits, the time saving component is variable. It can be argued whether the saved time has economic value or not, because the unit of saved time is very small. The point at issue is whether a person can use the saved time to be economically active or not. Therefore, the case of excluding the time savings was examined in this study.

In summary, the cases of sensitivity analysis are as follows:

Case-1 Increase construction costs by 10 percent

Case-2 Reduce benefits by only considering vehicle operating cost savings (ie, reduce benefits by about 58 percent)

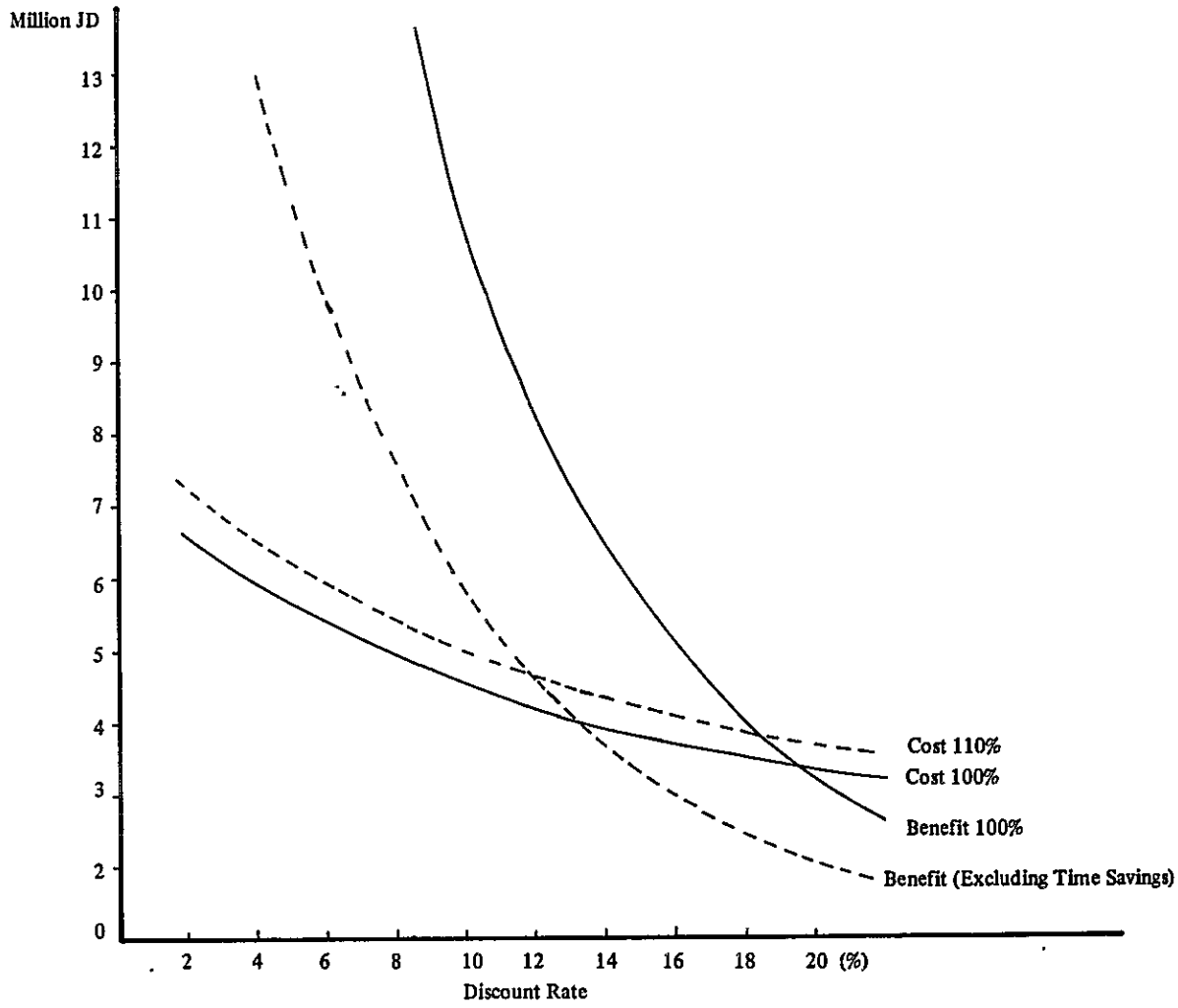
Case-3 Combination of cases 1 and 2.

Using these assumptions, the discounted costs and benefits at various discount rates are as shown in Fig. 12.1.

According to this figure, even in the worst case, that is Case-3, the project is economically feasible with IRR at about 12%.

As a result of increasing construction costs by 10 percent, IRR decreases by about 1 percent.

Fig. 12.1 Sensitivity of Costs and Benefits



12.3 Cost-Benefit Ratios by Section

Although the project cost-benefit ratio for Alternative II was 2.42, B/C ratios by section were calculated in order to examine the importance of each section. As mentioned in an earlier chapter, Section 1 is the eastern part of Boundary Ring Road and includes Connecting Road A, Section 2 is the nothern part and Section 3 is the western part of Boundary Ring Road. Outer Ring Road including Connecting Road B is also considered as one section.

Total benefits by year were subdivided by using estimated Vehicle-km by section.

Costs and benefits by section were discounted the same as in the economic analysis of the alternatives.

Discounted costs and benefits by section are summarized in Table 12.2.

Table 12.2 Cost-Benefit Ratios by Section
(Discounted at 10% using 1981 prices)

(Unit: 1,000 JD)

	Costs	Benefits	B/C
BRR			
Section 1	1,007	3,718	3.69
Section 2	1,006	1,633	1.62
Section 3	1,260	955	0.76
ORR	1,290	4,738	3.67
Total	4,563	11,044	2.42

Source : Study Team

The eastern part of this project, ie, Section 1 of BRR and ORR, have relatively high B/C ratios. Although Section 2 and 3 have low B/C values, these sections are essential to the project in that they reduce the Irbid City through-traffic. Whereas these sections might not be recommendable as individual projects, they are indispensable and economically justificable to this project as a whole.

12.4 Project Evaluation

1) Significance of the ring roads

Land-use readjustment is proceeding along the ring roads so that a residential area will be produced which will absorb growing population of Irbid City. Accordingly the ring roads are very important as arterial roads inside residential districts. They also are very important as by-passes for through traffic since only a part of through traffic can be served by the inner ring road which is difficult to improve.

2) Environmental, technical and financial evaluation

It is very significant that traffic congestion in the urban center will be reduced and the environment improved as a result of through traffic being detoured by the ring roads.

Comparing Alternative I in which all the roads will be completed by 1985, mainly with 2 lanes, and Alternative II which is nearly the same excluding Section 2 of Boundary Ring Road, Alternative I is a little more effective than Alternative II from the viewpoint of improving the urban environment as soon as possible.

Traffic noise and exhaust gases are not significant factors in either case.

However, by Alternative I, investment will be concentrated in one period, and accordingly, land prices will increase in one period. The negative impact of Alternative I will be larger than that of Alternative II.

Soil conditions of the site are good and there are no complicated structures; technically, there are no problems.

Jordanian contractors should be able to execute the ring roads without any difficulty.

The investment period of Alternative II is longer than that of Alternative I. Accordingly, Alternative II can be financed a little more easily.

3) Economic evaluation

The cost-benefit ratio (B/C) of Alternatives I and II are 2.23

and 2.42 respectively. Threfore, both alternatives are quite good economic investments.

Only a few simple structures are included in the ring roads. Accordingly, construction cost is lowered and the B/C ratio rises. Alternative II is a little more effective for investment.

Even in the case where cost increases to 110% and time saving benefit is excluded, IRR becomes 12%.

As for B/C by sections, the B/C of Section 1 of the Boundary Ring Road and Outer Ring Road are largest. Hence, the investment for these sections are most effective.

4) Conclusion

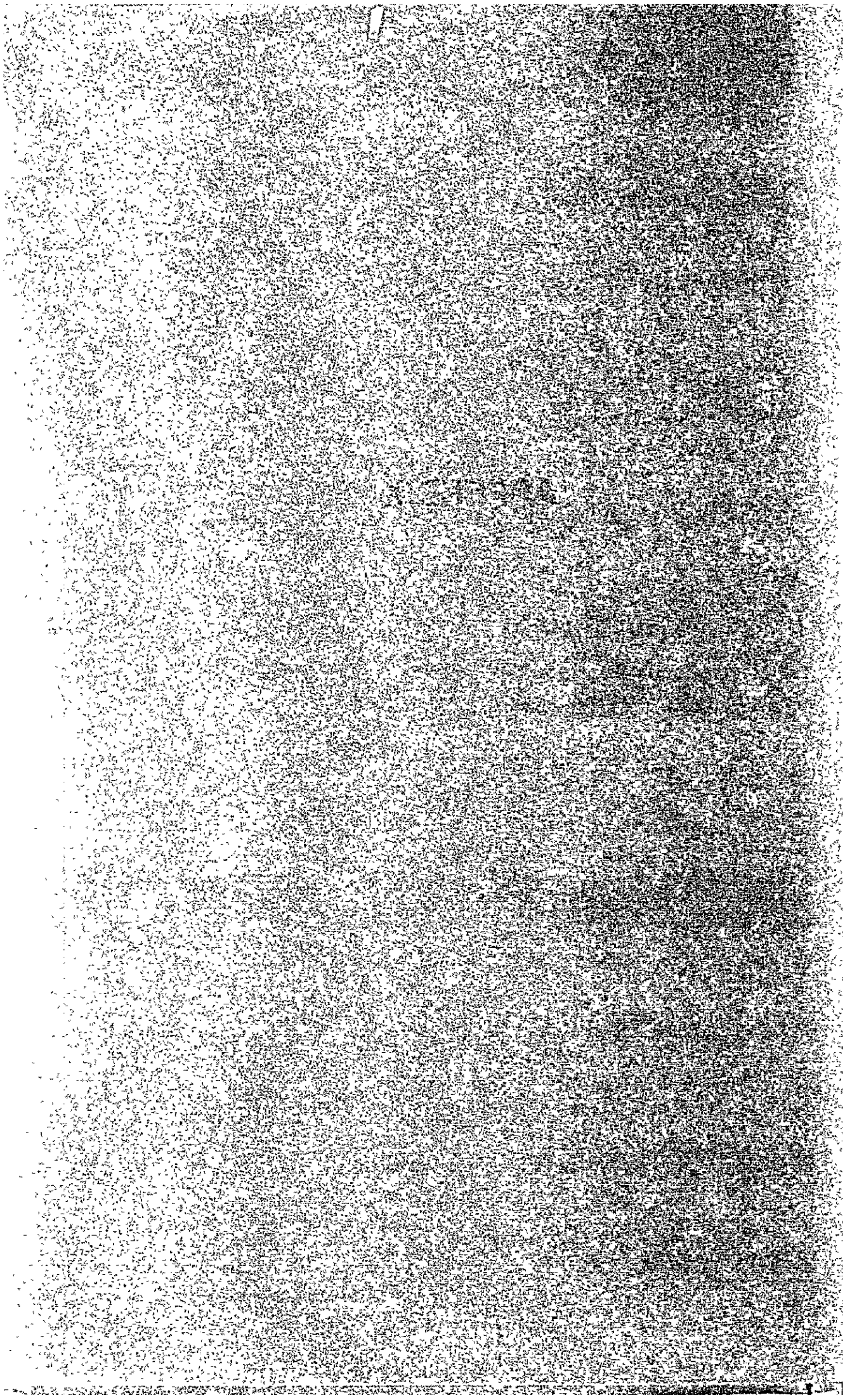
As a conclusion, the ring road is very important for the urban function of Irbid City.

The project is technically and economically feasible.

Alternative II is a little more recommendable than Alternative I as summarized below.

Project Benefits	Alternative I	Alternative II
Quicker Environmental Improvement	*	
Longer Financing Period		*
Larger Economic Benefits		*

APPENDIX



Appendix 1

SCOPE OF WORK
FOR
THE FEASIBILITY STUDY ON THE RING ROADS CONSTRUCTION PROJECT IN IRBID CITY IN THE HASHEMITE KINGDOM OF JORDAN

Agreed

Between

NATIONAL PLANNING COUNCIL

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Dated: December, 1980

Dr. (Hanna Odah) President National Planning Council	(Kimio Chiba) Team Leader Feasibility Study Team Japan International Cooperation Agency

SCOPE OF WORK

FOR

THE FEASIBILITY STUDY ON THE RING ROADS

CONSTRUCTION PROJECT IN IRBID CITY

IN THE HASHEMITE KINGDOM OF JORDAN

I. INTRODUCTION

In response to the request of the Government of the Hashemite Kingdom of Jordan (hereinafter referred to as the Government of Jordan), the Government of Japan has decided to conduct the feasibility study on the Ring Roads of Irbid Construction Project in Jordan, in accordance with laws and regulations in force in Jordan as far as field activities are concerned and in Japan for the other Study activities. The Study will be carried out through the Japan International Cooperation Agency (hereinafter called JICA), which is the official agency responsible for the implementation of technical cooperation programs of the Government of Japan. JICA will carry out the Study in close cooperation with authorities concerned of the Government of Jordan.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to assist the Government of Jordan to prepare a feasibility study of the Irbid Ring Roads Project as an extension of the pre-feasibility study conducted in the Phase II. The Study will provide detailed information to the Government of Jordan for decision on further implementation of the proposed Irbid Ring Roads Project.

III. SCOPE OF THE STUDY

Introduction

In order to attain the stated objective, the Study will be carried out on the basis of the framework formulated in the Phase II Study, and make in-depth analysis of the following eleven major Study items to the extent which is necessary to confirm the feasibility of Irbid Ring Roads within the time and resources earmarked by the Study. JICA should cooperate with the Irbid Urban Regional Planning Group (IURPG) staff during the Study to agree on the alignments of the Ring Roads.

1. Performance of Field Reconnaissance

- Visit the concerned area at the beginning of the Study to obtain general information, such as topography, land use, situation of traffic, etc.

2. Economic Study of the Area Concerned

- General Study of traffic generators, such as population, production (total, primary, secondary and tertiary industries), trade, services, etc.;
- review of existing urban and regional master plans;
- review of present situation of land-use and the Government plans and policies in this respect.

3. Traffic Study

- Inventory of main roads systems, such as road networks, intersections, length, width, maintenance status, etc.;
- survey of traffic on main roads, such as volume, speed, accidents, number of vehicles, origin, destination, etc.;
- analysis of the present capacity of the main roads in reference to the present and projected roads traffic;
- forecast of the traffic demand (for 20 years);
- assignment of future traffic, including diverted traffic, to the main Roads.

4. Hydrological Study

- Collecting data for designing of drainage (i.e. maximum rainfall per day and per hour).

5. Soil Investigations

- Sampling by auger boring or machine boring;
- testing the soil in laboratory and field, such as CBR, LL, FL, N-Value, etc.;
- on the basis of above tests, the stability of structures and thickness of pavement will be examined.

6. Selection of Alternatives

- On the basis of results through items 1 to 5, several alternatives will be proposed.

7. Surveying

- Supplementary surveying, cross sections and topography, will be executed if necessary.

8. Preliminary Engineering Design

- Scale of 1/2500 map will be produced;
- decision of engineering design standard;
- design of horizontal and vertical alignment;
- analysis and design of intersections;
- structural design;
- pavement design.

9. Study of Road Construction Materials and Labor Force

- Quality, quantity and price;
- whether local product or foreign one will be needed.

10. Estimation of Construction, Meintenance and Vehicle Operation Costs

- Estimation of construction, maintenance cost divided into foreign and local costs and for both economic and financial costs.

11. Evaluation of the Project

- Carry out cost-benefit analysis (Benefit Cost Ratio (B/C), Internal Rate of Return (IRR), Sensitivity Analysis (SA);
- Conclusion;
- Recommendations.

IV. REPORTS

JICA will prepare and submit the following reports in English to the Government of Jordan:

1. Inception Report, within one month from the beginning of the field survey, (50 copies).

2. Progress Report, at the end of the field survey in Phase I and at the beginning and the end of the field survey in Phase II, (50 copies).

3. Draft Final Report, within two months after completion of the field survey in Phase II (50 copies). The Government of Jordan will provide JICA with its comments within one and a half month after the submission of the Draft Final Report.

4. The Final Report, within two months after the receipt of comments from the Government of Jordan on the Draft Final Report (100 copies) together with an Executive Summary Report (200 copies).

V. CONTRIBUTION OF THE GOVERNMENT OF JORDAN

For the purpose of facilitating an efficient and rapid execution of the field study in Jordan, the following conveniences, facilities and services shall be provided by the Government of Jordan.

1. To exempt the Study Team from any taxes and duties on equipment and materials which are temporarily brought into, (against bank guarantee) and taken back from Jordan by the Study Team for the field study.

2. To exempt the Japanese team members from income taxes and charges of any kind imposed on, or in connection with the Project local expenses paid out from remittances from abroad.

3. To grant necessary clearance for the field survey work upon request of the Study Team.

4. To provide the Team with suitable offices, one in Amman and one in Irbid, with necessary office furniture and services for the Study.

5. To assign counterpart personnel to the Team during the Survey period.

6. To provide the Team with the relevant available data, information and materials required for the Study.

7. To make arrangements for the Team to take back home collected data, maps and materials necessary for the Study.

8. To provide the Team with local laborers needed for the study.

9. To assist the team in making arrangements for medical services.

10. To provide the Team with security in the study area, it should be understood that the members of the Team will at all times during their stay in Jordan abide by the local laws and regulations.

VI. CONTRIBUTION OF THE GOVERNMENT OF JAPAN

In connection with the Study, the Government of Japan, through JICA, will conduct the following:

1. On-the-job training of counterpart personnel during the field works in Jordan.

2. Training of selected counterpart personnel in Japan.

3. Salary for students, secretaries, typists, and laborers for field survey needed to be paid.

4. The cost of soil tests and computer analysis to be paid.

VII. STUDY SCHEDULE (TENTATIVE SCHEDULE)

	1981												1982					
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Inception Report			○															
Field Survey			(Phase I)					(Phase II)										
Progress Report				○			○		○									
Study in Japan					—	—												
Study in Japan										—	—							
Draft Final Report											○							
Comments on Draft Final Report												○						
Study in Japan													—	—				
Final Report														○				

Appendix 2

List of Major Data Sources

1. Planning

- Statistical Yearbook : 1961 (No. 12)
  1963 (No. 14)
  1964 (No. 15)
  1966 (No. 17)
  ⋮
  1979 (No. 30)

  (Department of Statistics)

- Jordan Five Year Plan for Economic & Social Development

  1976 - 1980
  1981 - 1985

  (National Planning Council)

- Climatic Atlas of Jordan/1971

  (Ministry of Transport : Meteorological Department)

- Summary of Climatological Data (1966 - 1975)

  (Ministry of Transport :Meteorological Department)

- National Accounts in Jordan

  1975
  1967 - 1977
  1970 - 1978
  1975 - 1980

  (Department of Statistics)

- Agriculture Statistical Yearbook and Agricultural Sample Survey 1979

  (Department of Statistics)

- Annual Report : 1974
  1979

  (Department of Land & Surveys)

- First Census of Population and Housing
  18 November 1961 - Vol. 4, Methods Report

  (Department of Statistics)

- Population Census & Internal Migration for Amman,
  Jerusalem, Zarqa, Ruseifa, Irbid & Aqaba/1976

  (Department of Statistics)

- Preliminary Results for the Citizens Census as it is in
  November 10th, 1979 (Adjustable)

  (General Statistics Department)

- The Cost of Living Index : February, 1981

  (Department of Statistics)

- The Annual Report : 1978
  1979

  (Traffic & Drivers Licencing Department)

- 5-Year Plan for Development of Irbid Region : 1981 - 1985

  Irbid Governorate

  (Department of Planning & Development)

- Vehicle Accident Reports

  (Department of Public Security)

- The Multi-Purpose Household Survey
  January - April, 1976

  (Department of Statistics)

- Tables for Estimating Vehicle Operating Costs on Rural Roads in Developing Countries

  (Transport and Road Research Laboratory, 1976) in England

- Employment Survey for Establishments Engaging (5 Persons or More, June, 1979

  (Department of Statistics)

- The Labour Force Census, 1975

  (Department of Statistics)

- Central Bank of Jordan : Sixteenth Annual Report, 1979

  (Department of Research and Studies)

- Central Bank of Jordan : Monthly Statistical Bulletin, Vol. 16, No. 9; September, 1980

  (Department of Research and Studies)

- Annual Report for the Fiscal Year 1978

  (Ministry of Public Works)

- Municipalities & Town Services in Jordan, 1972

  (Ministry of Municipalities & Rural Affairs)

2. Engineering

- Highway Design Manual : 1972

  Ministry of Public Works

  (Highway Department)

- Standard Specifications for the Construction of Roads and Bridges/1974

  (Ministry of Public Works (Highway Department))

- Highway Maintenance Manual : 1981

  Ministry of Public Works

  (Highway Department)

- Master Road Plan : 1978 - 1982
  September, 1978

  (Wilbur Smith & Associates)

- Ramtha - Amman - Jerusalem Highway

  20 Year Plan for Development of the Highway
  August 1972

  (Harris - Western, a Joint Venture)

- Feasibility Study for Zarqa - Rihab - Irbid Expressway and Rihab - Syrian Border Connector
  November, 1979

  (Prepared by: Department of Planning & Research,
  Ministry of Public Wopks)

- Amman-Amman International Airport Highway Project, Feasibility Study and Preliminary Engineering

  (Ministry of Public Works, Aug. 1976)

- Aggregate Investigation in Jordan
  1981 (1) - (3)

  (Royal Scientific Society)

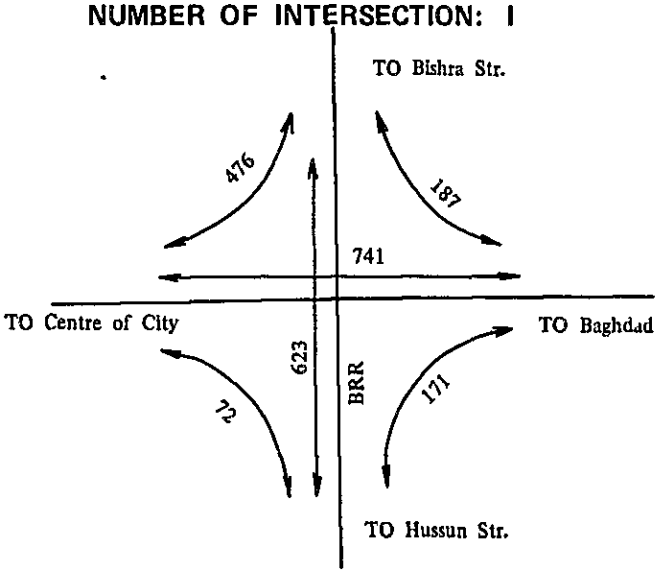
3. Maps

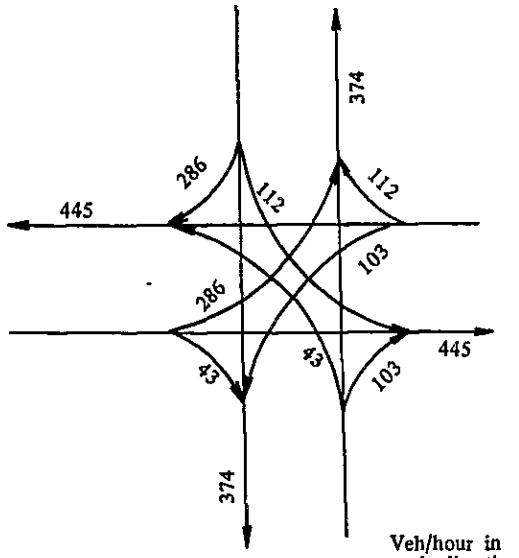
- Irbid Governorate Road Map, Scale : 1/100,000
- Irbid Governorate Zoning Map
- Irbid Region Topographic Map, Scale : 1/50,000
- Irbid City Map, Scale : 1/10,000
- Irbid City Map, Scale : 1/5,000
- Irbid City Topographic Map, Scale : 1/5,000
- Irbid City Topographic Map, Scale : 1/2,500
- Irbid City Urban Planning Map, Scale : 1/10,000
- Irbid City Land Re-adjustment Map, Scale : 1/2,500 - 6 kinds
- Irbid Region Aerial Photograph, Scale : 1/25,000
- Irbid City Aerial Photograph, Scale : 1/2,500

Appendix 3 TRAFFIC ANALYSIS OF INTERSECTION

Year: 1995

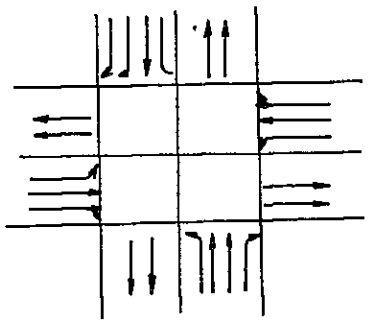
NUMBER OF INTERSECTION: I





Traffic Phase (VEH/H)		Traffic Volume V (PCU/H)	Possible Capacity Cp (PCU/H)	Integrated Congestion Ratio Y = V/Cp	Modified Y (%)	Phase Time (SEC)
1	286 374 / 374 103	286 374 374 103	2 x 1200 x 0.85 = 2040 1800 x 0.85 = 1530 1200 x 0.85 = 1020	0.140 0.244 0.101	28.6	29 + 3
2	112 / 43	112 43	1200 x 0.850 = 1020	0.110	12.9	13.+ 3
3	112 / 445 445 / 43	112 445 557 445 43 488	(1200+1800) x 0.850 = 2550	0.218	25.6	25 + 3
4	103 / 286	103 286	1200 x 0.850 = 1020	0.280	32.9	33 + 3
TOTAL				0.852	100.0	100 + 12

LANE ARRANGEMENT

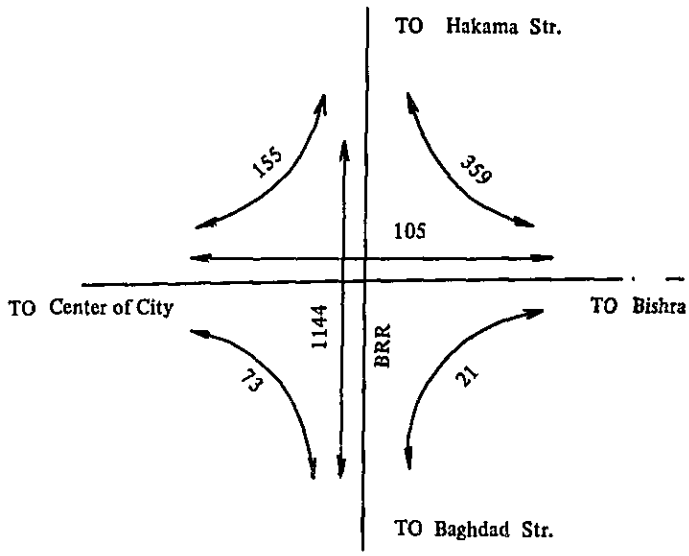


NOTES

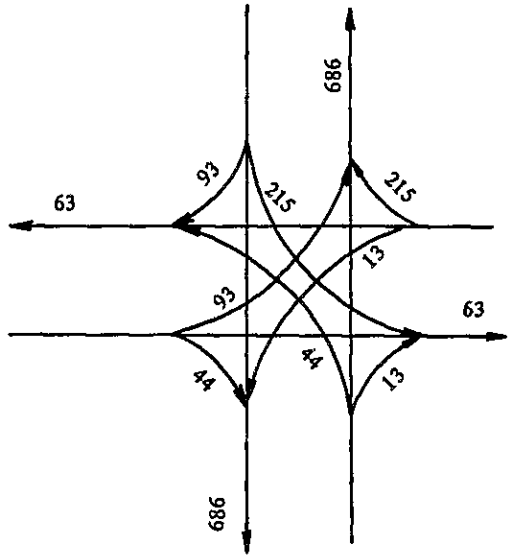
1. Traffic Capacity per Lane
   Through Lane = 1800 veh (pcu)/Green Hour
   Turning Lane = 1200 veh (pcu)/Green Hour
2. Peak Factor = 10%
3. Percentage of Heavy Vehicles = 23%
4. Directional distribution of Future Design Hourly Volume = 60%

NUMBER OF INTERSECTION: II

Year: 1995



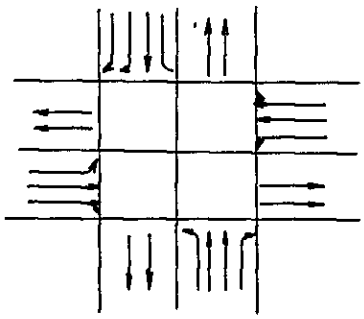
Veh/hour



Veh/hour in each direction

Traffic Phase (VEH/H)		Traffic Volume V (PCU/H)	Possible Capacity Cp (PCU/H)	Integrated Congestion Ratio Y = V/Cp	Modified Y (%)	Phase Time (SEC)
1	93 686 686 13	93 686 686 13	1200 x 0.850 = 1020 2 x 1800 x 0.850 = 3060	0.091 0.224	30.4	30 + 3
2	215 44	215 44	1200 x 0.850 = 1020	0.211	28.6	29 + 3
3	215 63 63 44	215 63 63 44	1200 x 0.850 = 1020 1800 x 0.850 = 1530	0.211 0.041	28.6	29 + 3
4	13 93	13 93	1200 x 0.850 = 1020	0.091	12.4	12 + 3
			TOTAL	0.737	100.0	100 + 12

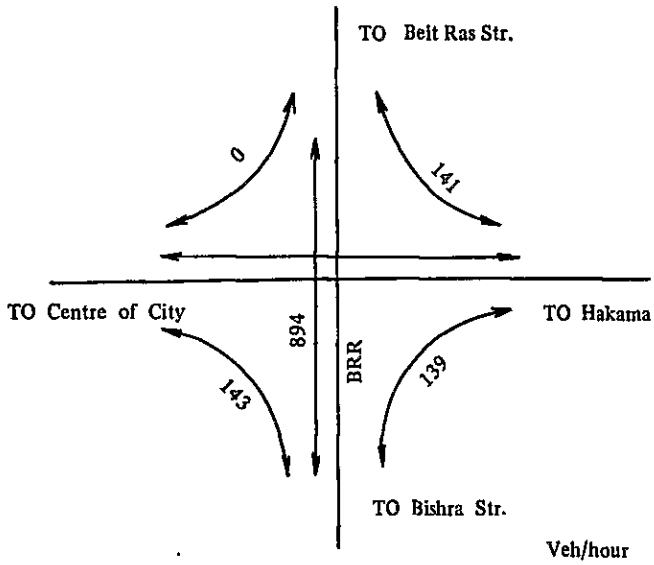
LANE ARRANGEMENT

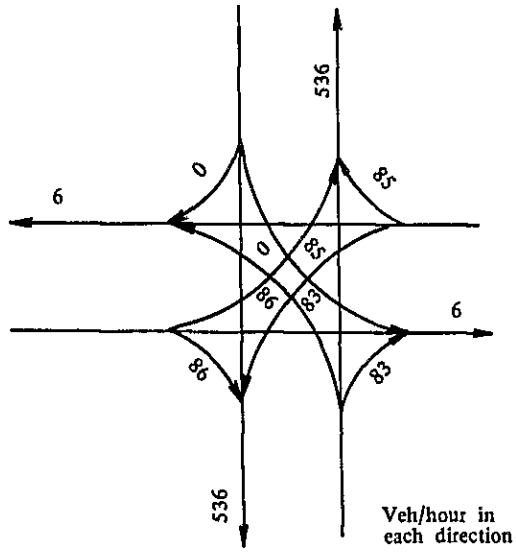


NOTES

1. Traffic Capacity per Lane
   Through Lane = 1800 veh (pcu)/Green Hour
   Turning Lane = 1200 veh (pcu)/Green Hour
2. Peak Factor = 10%
3. Percentage of Heavy Vehicles = 23%
4. Directional distribution of Future Design Hourly Volume = 60%

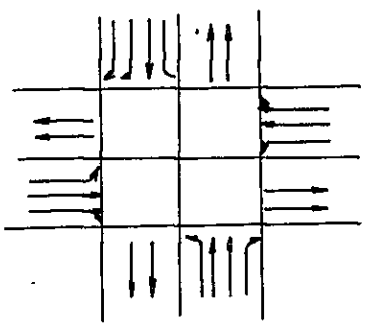
NUMBER OF INTERSECTION: III **Year: 1995**





	Traffic Phase (VEH/H)	Traffic Volume V (PCU/H)	Possible Capacity Cp (PCU/H)	Integrated Congestion Ratio Y = V/Cp	Modified Y (%)	Phase Time (SEC)
1	0 536 536 83	536 536 83	2 x 1800 x 0.850 = 3060 1200 x 0.850 = 1020	0.175 0.081	40.7	41 + 3
2	85 86	85 86	1200 x 0.850 = 1020	0.084	19.5	19 + 3
3	85 6 6 86	85 6 91 6 92 86	1200 x 0.850 = 1020	0.090	20.9	21 + 3
4	0 83	83	1200 x 0.850 = 1020	0.081	18.9	19 + 3
			TOTAL	0.430	100.0	100 + 12

LANE ARRANGEMENT

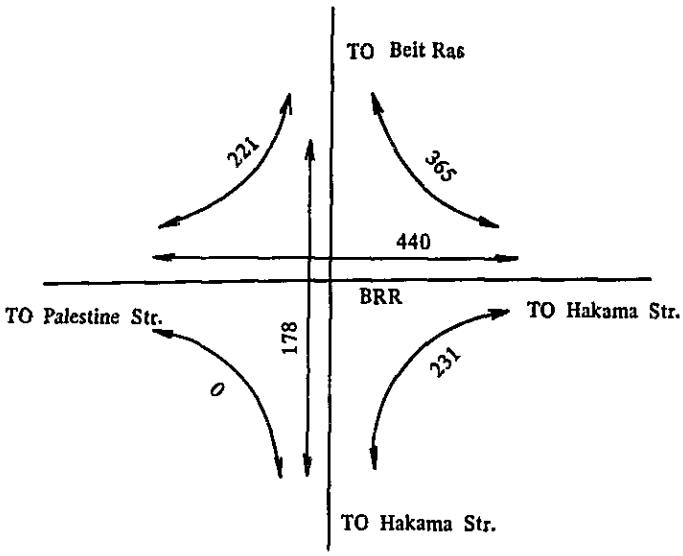


NOTES

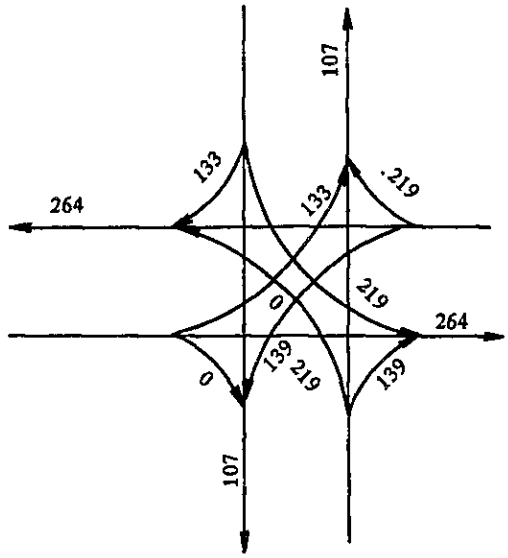
1. Traffic Capacity per Lane
   Through Lane = 1800 veh (pcu)/Green Hour
   Turning Lane = 1200 veh (pcu)/Green Hour
2. Peak Factor = 10%
3. Percentage of Heavy Vehicles = 23%
4. Directional distribution of Future Design Hourly Volume = 60%

NUMBER OF INTERSECTION: IV

Year: 1995



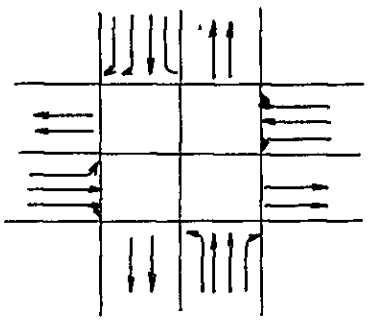
Veh/hour



Veh/hour in each direction

Traffic Phase (VEH/H)		Traffic Volume V (PCU/H)	Possible Capacity Cp (PCU/H)	Integrated Congestion Ratio Y = V/Cp	Modified Y (%)	Phase Time (SEC)
1	133 107 / 107 139	133 107 107 139	1800 x 0.850 = 1530 1200 x 0.850 = 1020	0.070 0.136	18.2	18 + 3
2	219 / 0	219 0	1200 x 0.850 = 1020	0.215	28.8	29 + 3
3	219 / 264 / 0	219 264 264 + 0 = 264	1200 x 0.850 = 1020 2 x 1800 x 0.850 = 3060 1200 x 0.850 = 1020	0.215 0.086 0.259	34.7	35 + 3
4	139 / 133	139 133	1200 x 0.850 = 1020	0.136	18.3	18 + 3
			TOTAL	0.746	100.0	100 + 12

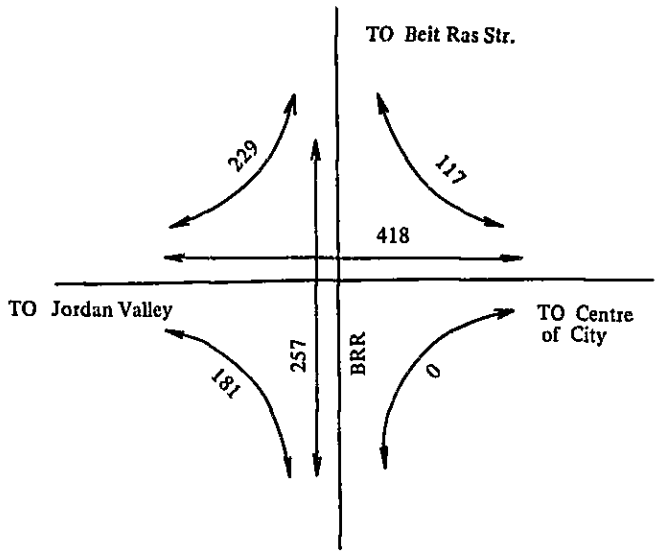
LANE ARRANGEMENT



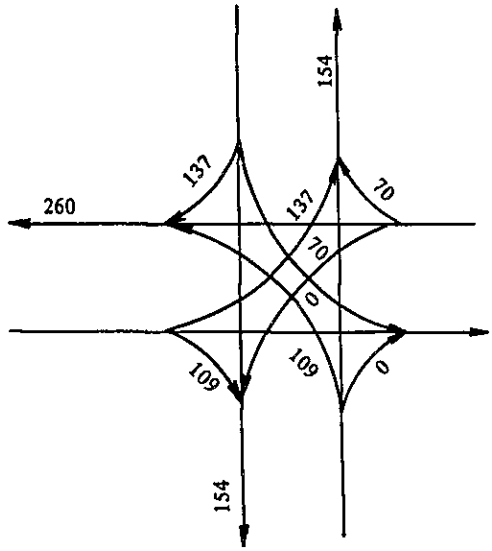
NOTES

1. Traffic Capacity per Lane
   Through Lane = 1800 veh (pcu)/Green Hour
   Turning Lane = 1200 veh (pcu)/Green Hour
2. Peak Factor = 10%
3. Percentage of Heavy Vehicles = 23%
4. Directional distribution of Future Design Hourly Volume = 60%

NUMBER OF INTERSECTION: V **Year: 1995**



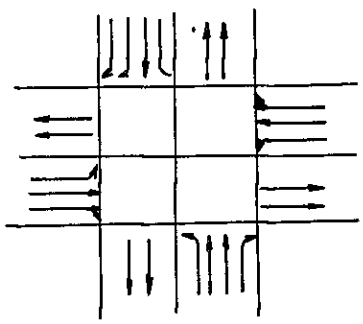
Veh/hour



Veh/hour in each direction

Traffic Phase (VEH/H)		Traffic Volume V (PCU/H)	Possible Capacity Cp (PCU/H)	Integrated Congestion Ratio Y = V/Cp	Modified Y (%)	Phase Time (SEC)
1	137 154 154 0	137 + 154 = 291 154 + 0 = 154	1200 x 0.850 = 1020	0.285	40.9	41 + 3
2	70 109	70 109	1200 x 0.850 = 1020	0.107	15.4	15 + 3
3	70 260 260 109	70 260 260 109	1800 x 0.850 = 1530 1200 x 0.850 = 1020	0.170 0.107	24.4	25 + 3
4	0 137	0 137	1200 x 0.850 = 1020	0.134	19.3	19 + 3
			TOTAL	0.696	100.0	100 + 12

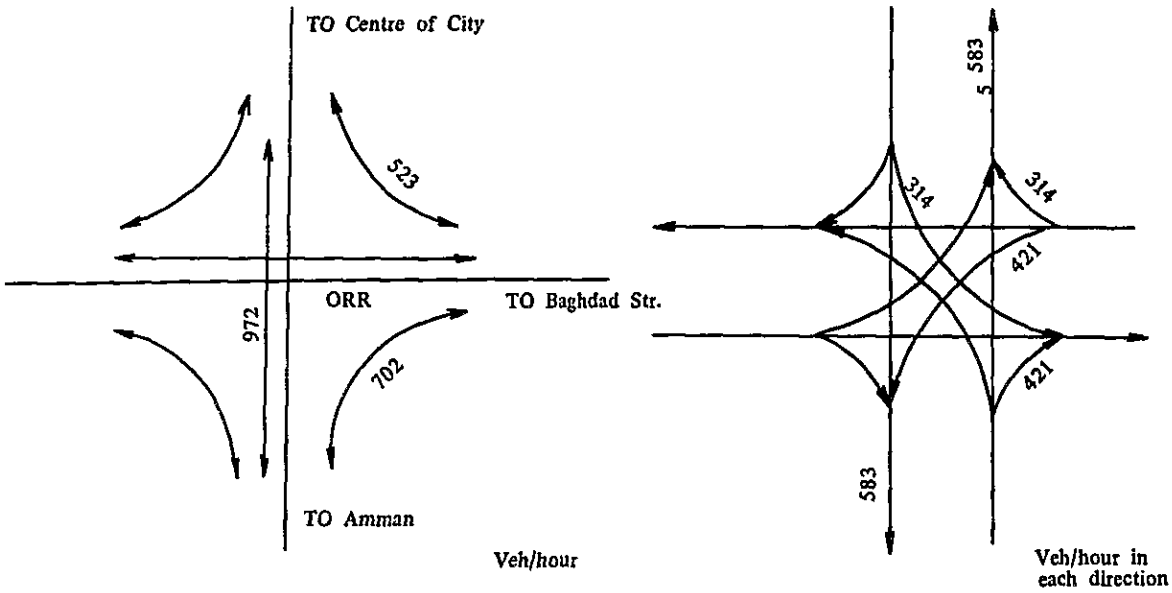
LANE ARRANGEMENT



NOTES

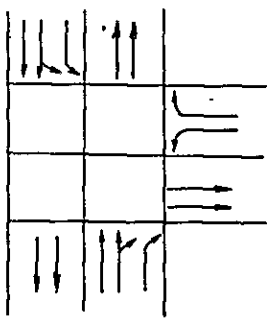
1. Traffic Capacity per Lane
   Through Lane = 1800 veh (pcu)/Green Hour
   Turning Lane = 1200 veh (pcu)/Green Hour
2. Peak Factor = 10%
3. Percentage of Heavy Vehicles = 23%
4. Directional distribution of Future Design Hourly Volume = 60%

NUMBER OF INTERSECTION: VI **Year: 1995**



Traffic Phase (VEH/H)		Traffic Volume V (PCU/H)	Possible Capacity Cp (PCU/H)	Integrated Congestion Ratio Y = V/Cp	Modified Y (%)	Phase Time (SEC)
1	583 ↓ 583 ↑↑ ↱ 421	583 583 421	1800 x 0.850 = 1530 2 x 1200 x 0.850 = 2040	0.381 0.206	42.6	43 + 3
2	314 ↰	314	2 x 1200 x 0.850 = 2040	0.154	17.2	17 + 3
3	314 ↰ 421 ↱	314 + 735 421	2 x 1200 x 0.850 = 2040	0.360	40.2	40 + 3
			TOTAL	0.895	100.0	100 + 9

LANE ARRANGEMENT

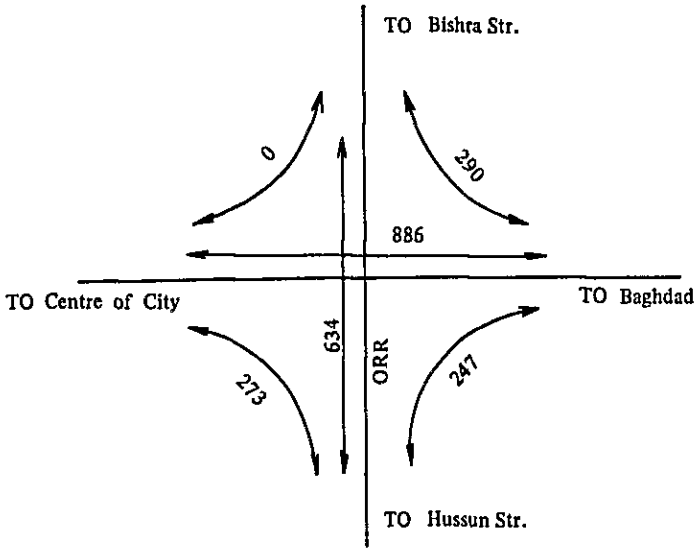


NOTES

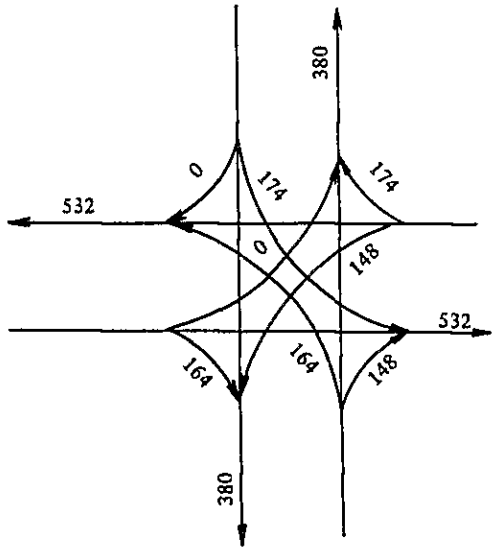
1. Traffic Capacity per Lane
   Through Lane = 1800 veh (pcu)/Green Hour
   Turning Lane = 1200 veh (pcu)/Green Hour
2. Peak Factor = 10%
3. Percentage of Heavy Vehicles = 23%
4. Directional distribution of Future Design Hourly Volume = 60%

NUMBER OF INTERSECTION: VII

Year: 1995



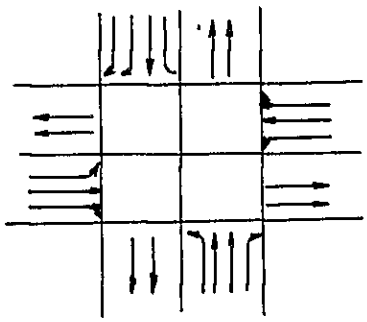
Veh/hour



Veh/hour in each direction

Traffic Phase (VEH/H)		Traffic Volume V (PCU/H)	Possible Capacity Cp (PCU/H)	Integrated Congestion Ratio Y = V/Cp	Modified Y (%)	Phase Time (SEC)
1	0 380 380 148	0 + 380 = 380 380 + 148 = 528	1800 x 0.850 = 1530 (1800+1200)x0.850= 2550	0.248 0.207	29.5	30 + 3
2	174 164	174 164	1200 x 0.850 = 1020	0.171	20.3	20 + 3
3	174 532 532 164	174 532 706 532 164 696	(1200+1800) x 0.85 = 2550	0.277	32.9	33 + 3
4	148 0	148 0	1200 x 0.850 = 1020	0.145	17.3	17 + 3
			TOTAL	0.841	100.0	100 + 12

LANE ARRANGEMENT



NOTES

1. Traffic Capacity per Lane
   Through Lane = 1800 veh (pcu)/Green Hour
   Turning Lane = 1200 veh (pcu)/Green Hour
2. Peak Factor = 10%
3. Percentage of Heavy Vehicles = 23%
4. Directional distribution of Future Design Hourly Volume = 60%